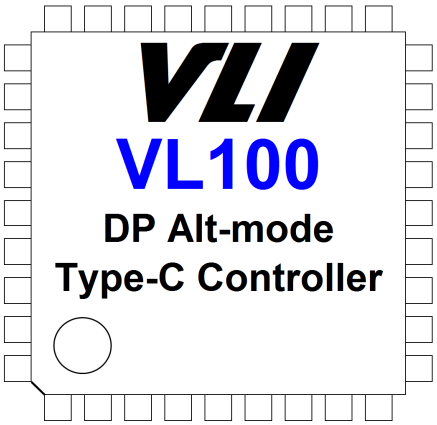
VIA Labs, Inc.

Data Sheet

VL100
DP Alt-mode Controller
for USB Type-C Device

May 15, 2015
Revision 0.60



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Revision History

Rev	Date	Initial	Note
0.6	05/15/2015	HC	Preliminary release

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Product Features

VL100

DisplayPort Alt-mode Controller for USB Type-C Device

- **CC Logic & PD Engine supporting one charging UFP and one sink port**
  - Compliant to USB Type-C Cable and Connector Specification Revision 1.1
  - Compliant to USB Power Delivery Specification Revision 2.0 Version 1.1
  - Integrated Type-C transceivers, supporting one charging UFP and one sink port
  - DP mode Discovery/Enter/Exit
  - DP configure & status update
  - Built-in pull-up/pull down resistors, including Rp, Rd, and Ra
- **DP Alt-mode Configuration**
  - Compliant to VESA DisplayPort Alt Mode on USB Type-C Standard Version 1.0
  - DFP_D Pin Assignment "C", "D", "E", and "F"
  - UFP_D Pin Assignment "C" and "D"
  - Built-in Aux_CH switch
  - DP source/sink connection detection
- **Charging UFP Capability**
  - Charging connected PD hosts either by external power or through VL100's Type-C sink port
  - Support up to PD power Profile 4
  - Support charging dead battery
- **USB Billboard Device**
  - Compliant to USB Device Class Definition for Billboard Devices Revision 1.0
  - Integrated in-house USB2.0 PHY
- **Fast 8051 Macro cell 80C32-Compatible Microcontroller**
  - Standard 1T 8051 instruction set
  - Embedded Mask ROM and SRAM
- **Built-in Voltage Regulators**
  - 5.0V to 3.3V LDO
  - 3.3V to 1.8V LDO
  - Auto power source selection between Vbus and Vconn
- **GPIOs for Special Function and Control**
  - 10 GPIOs in QFN40 and 5 GPIOs in QFN32 for application customization
  - One I^2C master interface
- **Misc**
  - Support external SPI flash for firmware upgrade
- **Physical**
  - QFN 40 green package (5x5x0.85 mm) for two Type-C ports
  - QFN 32 green package (5x5x0.85 mm) for one Type-C port
- **Certification**
  - TBD
- **Applications**
  - Type-C video adapters
  - Type-C Multi-function docks
  - Type-C TV, monitor, and projector

VL100 System Overview

VIA Lab's VL100 is a highly integrated single chip Displayport Alternate mode controller for USB Type-C devices that designed for applications like Type-C video adapters, Type-C TV/monitor/projector, and Type-C multi-function docking stations. Integrated Type-C charging UFP, VL100 can perform DP alt-mode video out functionality and simultaneously enable charging connected PD host once external power is detected. The external power source can come from 5V DC jack, from 5V USB power port, or from Type-C wall adapter attached onto VL100 integrated Type-C sink port. VL100's Device Policy Manager could negotiate power profiles with PD engine on Type-C wall adapter (source) and PD engine on connected PD host (sink) then enable power charge-through. Charging dead battery mode is supported as well. SBU1/SBU2 switch is built-in to support Type-C cable flipping feature. USB Billboard device is supported on USB2.0 to meet requirement defined by VESA DP Alt-Mode on USB Type-C spec.

Built-in required linear voltage regulators and power source detector, VL100 can work perfectly with power input either from 3.3V Vconn power or from 5V Vbus. Up to 10 GPIO pins are available for port power detection, power discharge control, power switch control, data switch control, or other special application usage. The SPI interface can support external flash for firmware upgrades through USB Billboard device. VL100 is available in QFN 40L (5x5x0.85 mm) and QFN 32L (5x5x0.85 mm) green packages to fit small form-factor design.

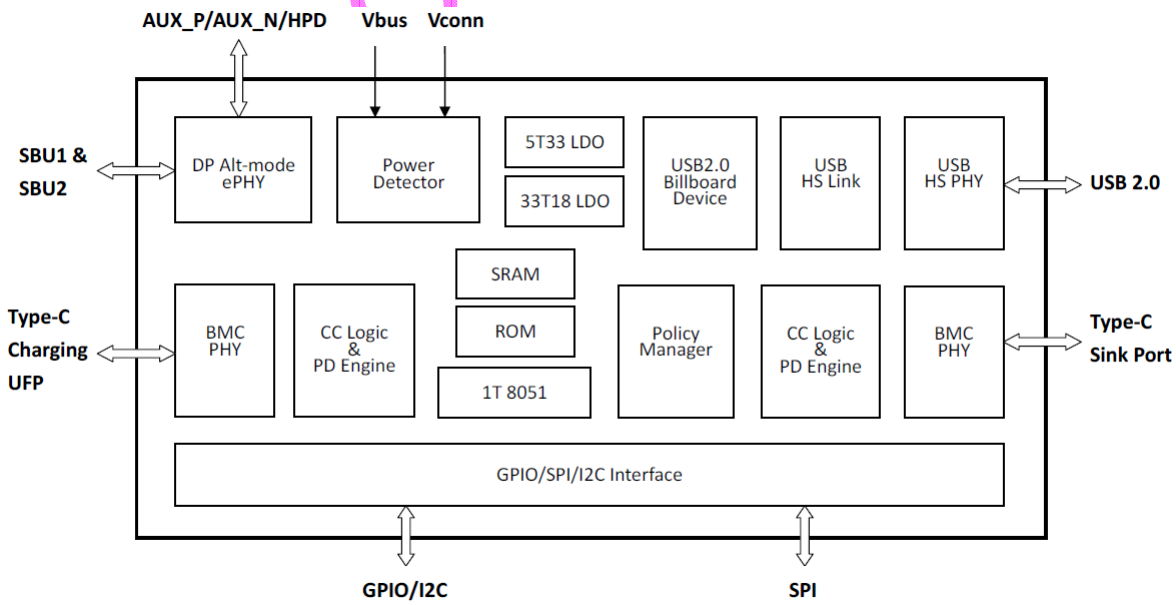


Figure 1 – VL100 Block Diagram

Typical Applications

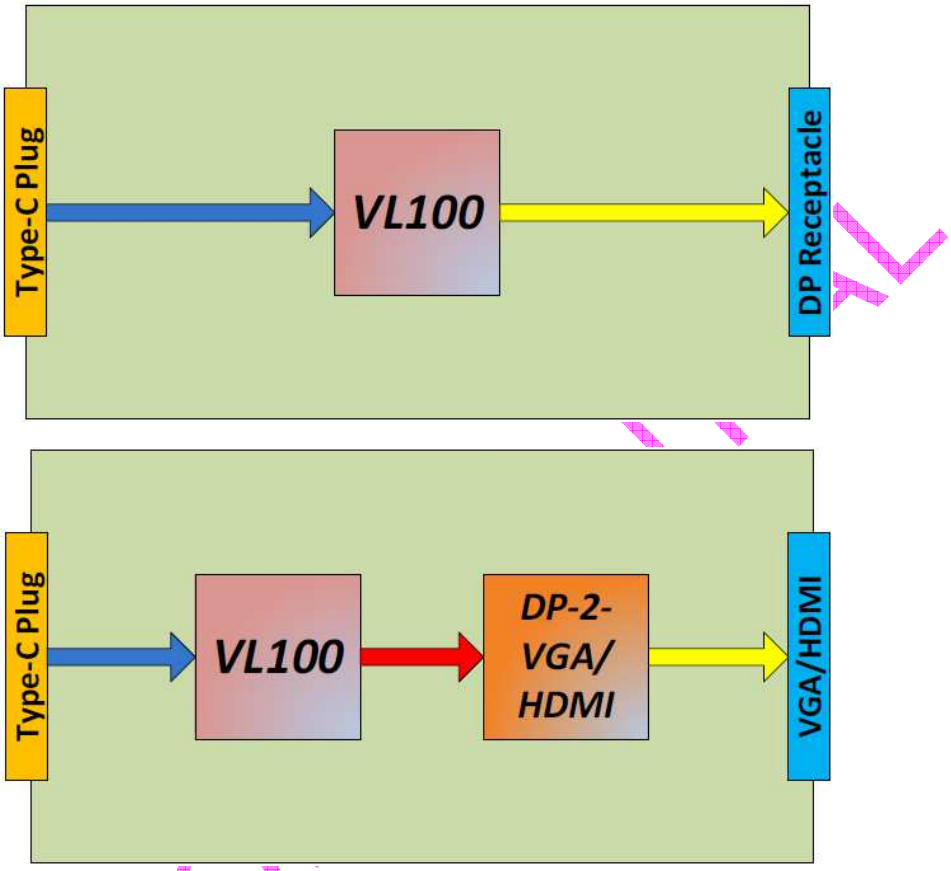


Figure 2 – Generic Type-C Video Adapters

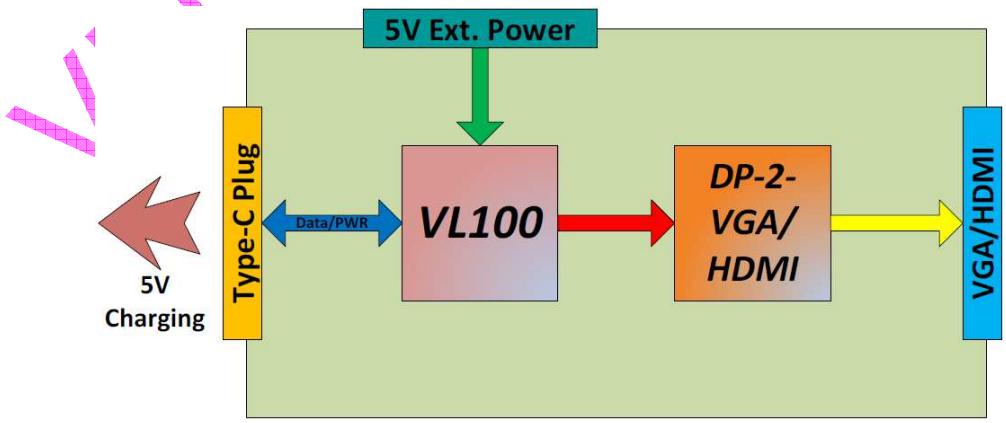


Figure 3 – Type-C Video Adapters with 5V Charging Capability

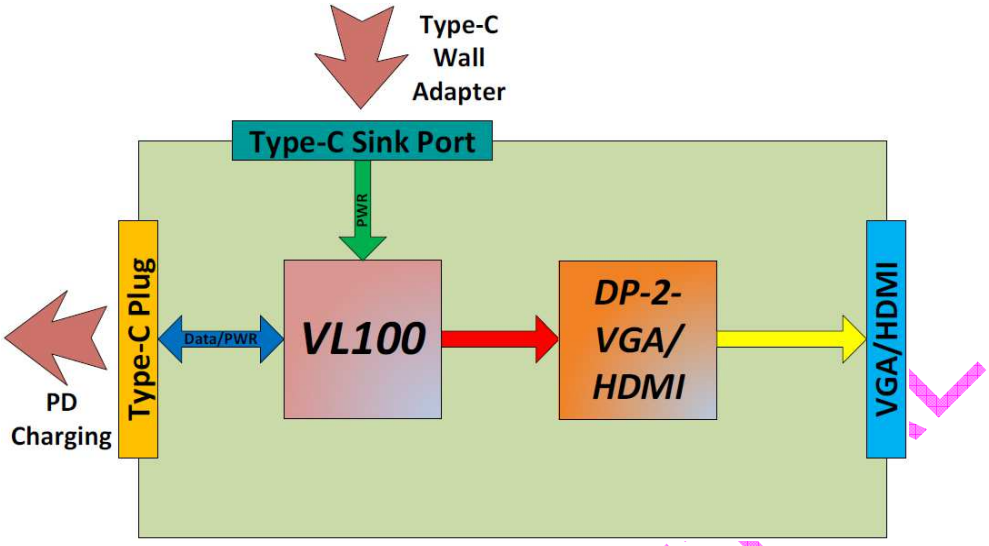


Figure 4 – Type-C Video Adapters with PD Charging Passed Thru Type-C Wall Adapter

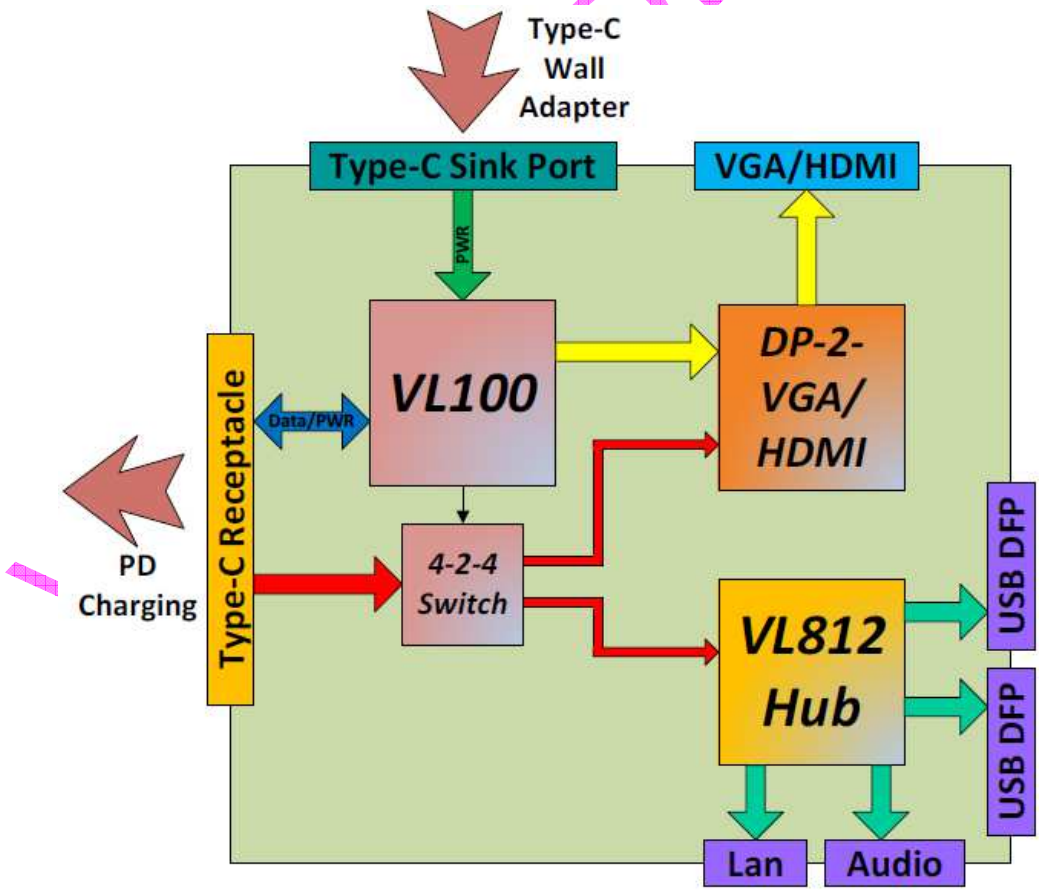


Figure 5 – Type-C Multi-function Dock

Pinout

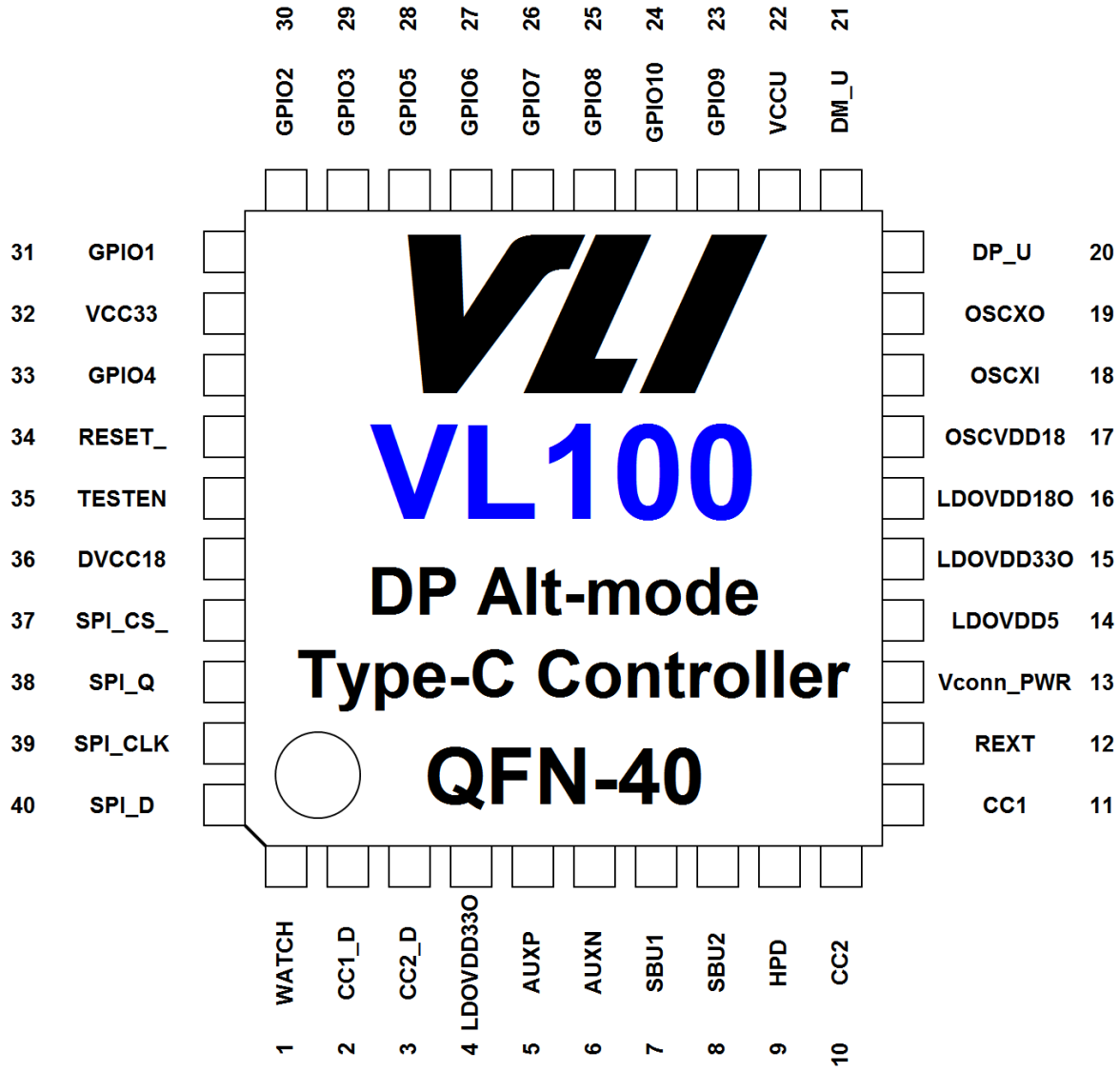


Figure 6 – VL100 QFN-40 Pin Diagram

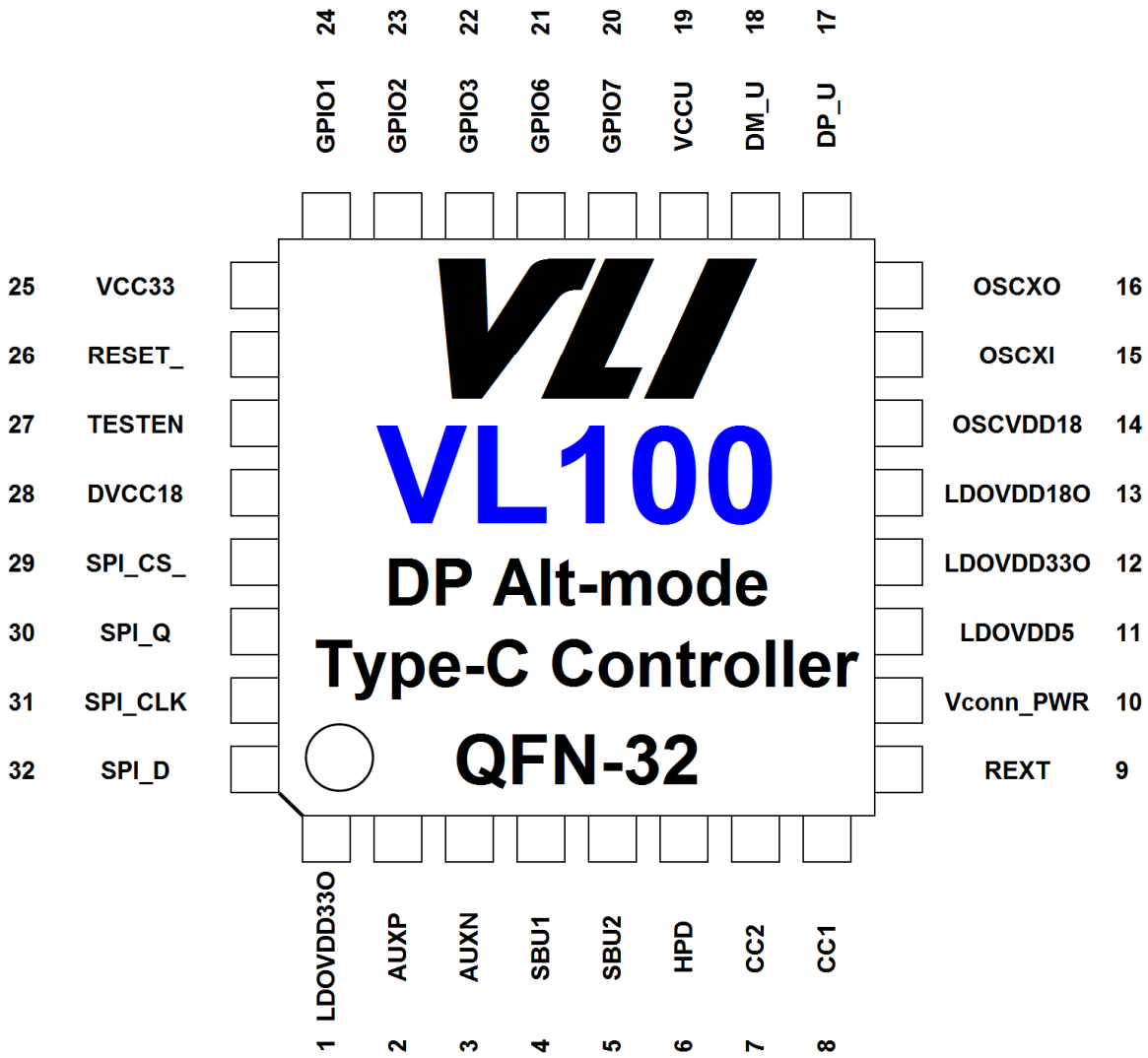


Figure 7 – VL100 QFN-32 Pin Diagram

Pin List

Table 1 – VL100 QFN-40 Pin List

Pin	Pin Name	Pin	Pin Name
1	WATCH	21	DM_U
2	CC1_D	22	VCCU
3	CC2_D	23	GPIO9
4	LDOVDD33O	24	GPIO10
5	AUXP	25	GPIO8
6	AUXN	26	GPIO7
7	SBU1	27	GPIO6
8	SBU2	28	GPIO5
9	HPD	29	GPIO3
10	CC2	30	GPIO2
11	CC1	31	GPIO1
12	REXT	32	VCC33
13	Vconn_PWR	33	GPIO4
14	LDOVDD5	34	RESET_
15	LDOVDD33O	35	TESTEN
16	LDOVDD18O	36	DVCC18
17	OSCVDD18	37	SPI_CS_
18	OSCXI	38	SPI_Q
19	OSCXO	39	SPI_CLK
20	DP_U	40	SPI_D

Table 2 – VL100 QFN-32 Pin List

Pin	Pin Name	Pin	Pin Name
1	LDOVDD33O	17	DP_U
2	AUXP	18	DM_U
3	AUXN	19	VCCU
4	SBU1	20	GPIO7
5	SBU2	21	GPIO6
6	HPD	22	GPIO3
7	CC2	23	GPIO2
8	CC1	24	GPIO1
9	REXT	25	VCC33
10	Vconn_PWR	26	RESET_
11	LDOVDD5	27	TESTEN
12	LDOVDD33O	28	DVCC18
13	LDOVDD18O	29	SPI_CS_
14	OSCVDD18	30	SPI_Q
15	OSCXI	31	SPI_CLK
16	OSCXO	32	SPI_D

Pin Descriptions

Signal Type Definition

Name	Type	Signal Description
Input	I	A standard input-only signal
Output	O	A standard active driver
Input/Output	I/O	A bi-directional signal
Analog bias	A_{BIAS}	Analog bias or reference signal. Must be tied to external resistor and/or capacitor bias network
Power	PWR	A power pin
Ground	GND	A ground pin

Type-C Interface

Pin Name	QFN40	QFN32	I/O	Signal Description
CC1	11	8	I/O	Charging UFP Configuration Channel 1
CC2	10	7	I/O	Charging UFP Configuration Channel 2
CC1_D	2	—	I/O	Sink Port Configuration Channel 1
CC2_D	3	—	I/O	Sink Port Configuration Channel 2
SBU1	7	4	I/O	Sideband Use 1
SBU2	8	5	I/O	Sideband Use 2

Billboard Interface

Pin Name	QFN40	QFN32	I/O	Signal Description
DP_U	20	17	I/O	USB 2.0 Bus Data Plus (D+)
DM_U	21	18	I/O	USB 2.0 Bus Data Minus (D–)

DP Alt-mode Interface

Pin Name	QFN40	QFN32	I/O	Signal Description
AUXP	5	2	I/O	DP AUX Channel Positive
AUXN	6	3	I/O	DP AUX Channel Negative
HPD	9	6	I	DP Hot Plug Detect

SPI Interface

Pin Name	QFN40	QFN32	I/O	Signal Description
SPI_CS_	37	29	O	Serial Flash Chip Enable
SPI_D	40	32	O	Serial Flash Data Input
SPI_Q	38	30	I	Serial Flash Data Output
SPI_CLK	39	31	O	Serial Flash Clock

Analog Command Block

Pin Name	QFN40	QFN32	I/O	Signal Description
OSCXI	18	15	I	24MHz Crystal Input
OSCXO	19	16	O	24MHz Crystal Output
REXT	12	9	A_{BIAS}	Connect to External Resistor (12.4Kohm, +/-1% accuracy)
LDOVDD5	14	11	PWR	5.0V Input for 5V-to-3.3V LDO
LDOVDD33O	4, 15	1, 12	PWR	3.3V Output Loading Capacitor Pin for 5V-to-3.3V LDO
LDOVDD18O	16	13	PWR	1.8V Output Loading Capacitor Pin for 3.3V-to-1.8V LDO
Vconn_PWR	13	10	PWR	Vconn Power Input (3.3V)

General Purpose I/O and Miscellaneous

Pin Name	QFN40	QFN32	I/O	Signal Description
RESET_	34	26	I	External Chip Reset
WATCH	1	—	O	UART Watch Pin
GPIO1	31	24	I/O	General Purpose I/O
GPIO2	30	23	I/O	General Purpose I/O
GPIO3	29	22	I/O	General Purpose I/O
GPIO4	33	—	I/O	General Purpose I/O
GPIO5	28	—	I/O	General Purpose I/O
GPIO6	27	21	I/O	General Purpose I/O
GPIO7	26	20	I/O	General Purpose I/O
GPIO8	25	—	I/O	General Purpose I/O
GPIO9	23	—	I/O	General Purpose I/O
GPIO10	24	—	I/O	General Purpose I/O

Test Pin

Pin Name	QFN40	QFN32	I/O	Signal Description
TESTEN	35	27	I	Test Mode Enable Do not connect for normal operation. Internal pull down

Power and Ground

Pin Name	QFN40	QFN32	I/O	Signal Description
VCC33	32	25	PWR	Digital 3.3V IO Power Input
DVCC18	36	28	PWR	Digital 1.8V Core Power Input
VCCU	22	19	PWR	Analog 3.3V Power Input
OSCVDD18	17	14	PWR	Oscillator Analog 1.8V Power Input

Electrical Specification

Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit	Note
T_{STG}	Storage Temperature	-55	125	°C	—
V_{DD33}	Power Supply Voltage	-0.5	3.69	V	—
V_{DD50}	Vbus Input Voltage	-0.5	5.5	V	—
V_O	Output Voltage at any output	-0.5	VCC+ 0.5	V	—
V_{ESD}	Electrostatic Discharge	—	2	kV	Human Body Model

Note: Stress above conditions may cause permanent damage to the device.
Functional operation of this device should be restricted to the conditions described.

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{CC33}	Digital IO power 3.3V	3.0	3.3	3.6	V
LDOVDD5	5V to 3.3V LDO 5V Power Input	4.5	5	5.5	V
Vconn_PWR	3.3V to 1.8V LDO 3.3V Power Input	3.0	3.3	3.6	V
V_{DD18I}	Digital Core power 1.8V	1.62	1.8	1.98	V
DGND	Ground	—	0	—	V
T_A	Ambient Temperature	0		70	°C

General IO DC Characteristics

Symbol	Parameter	Min	Max	Unit	Note
V_{IL}	Input Low Voltage	-0.30	0.8	V	—
V_{IH}	Input High Voltage	2.0	3.6	V	—
V_{OL}	Output Low Voltage	—	0.4	V	IOL=15.8mA
V_{OH}	Output High Voltage	2.4	—	V	IOH=26.5mA
I_{IL}	Input Leakage Current	—	+/-10	μA	0<VIN<VCC
I_{OZ}	Tristate Leakage Current	—	+/-10	μA	0<VOUT<VCC

Internal 3.3V to 1.8V LDO Regulator

Parameter	Min	Typ.	Max	Unit	Note
Input Voltage	3.0	3.3	3.6	V	
Output Voltage	1.72	1.8	1.89	V	
Max. Output Current			100	mA	
Output Voltage Tolerance		+/- 5%			

Internal 5V to 3.3V LDO Regulator

Parameter	Min	Typ.	Max	Unit	Note
Input Voltage	4.5	5.0	5.5	V	

Output Voltage	3.135	3.3	3.465	V
Max. Output Current			100	mA
Output Voltage Tolerance		+/- 5%		

PD BMC DC/AC Characteristics

Symbol	Parameter	Min	Max	Unit	Note
$V_{BMCSWING}$	Voltage Swing	1.05	1.2	V	—
Z_{BMCDRV}	Drive Output Resistance	33	75	Ω	—
T_{BMCR}	Rise Time	300		ns	—
T_{BMCF}	Fall Time	300		ns	—

USB Full Speed DC/AC Characteristics

Symbol	Parameter	Min	Max	Unit	Note
V_{FSIH}	Full-speed Input High	2.0		V	—
V_{FSIL}	Full-speed Input Low		0.8	V	—
V_{FSCM}	Differential Common Mode Voltage	0.8	2.5	V	—
V_{FSOL}	Full-speed Output Low	0.0	0.3	V	—
V_{FSOH}	Full-speed Output High	2.8	3.6	V	—
T_{FSR}	Full-speed Rise Time	4	20	ns	—
T_{FSF}	Full-speed Fall Time	4	20	ns	—
V_{FSCRS}	Full-speed Output Signal Crossover Voltage	1.3	2.0	V	—

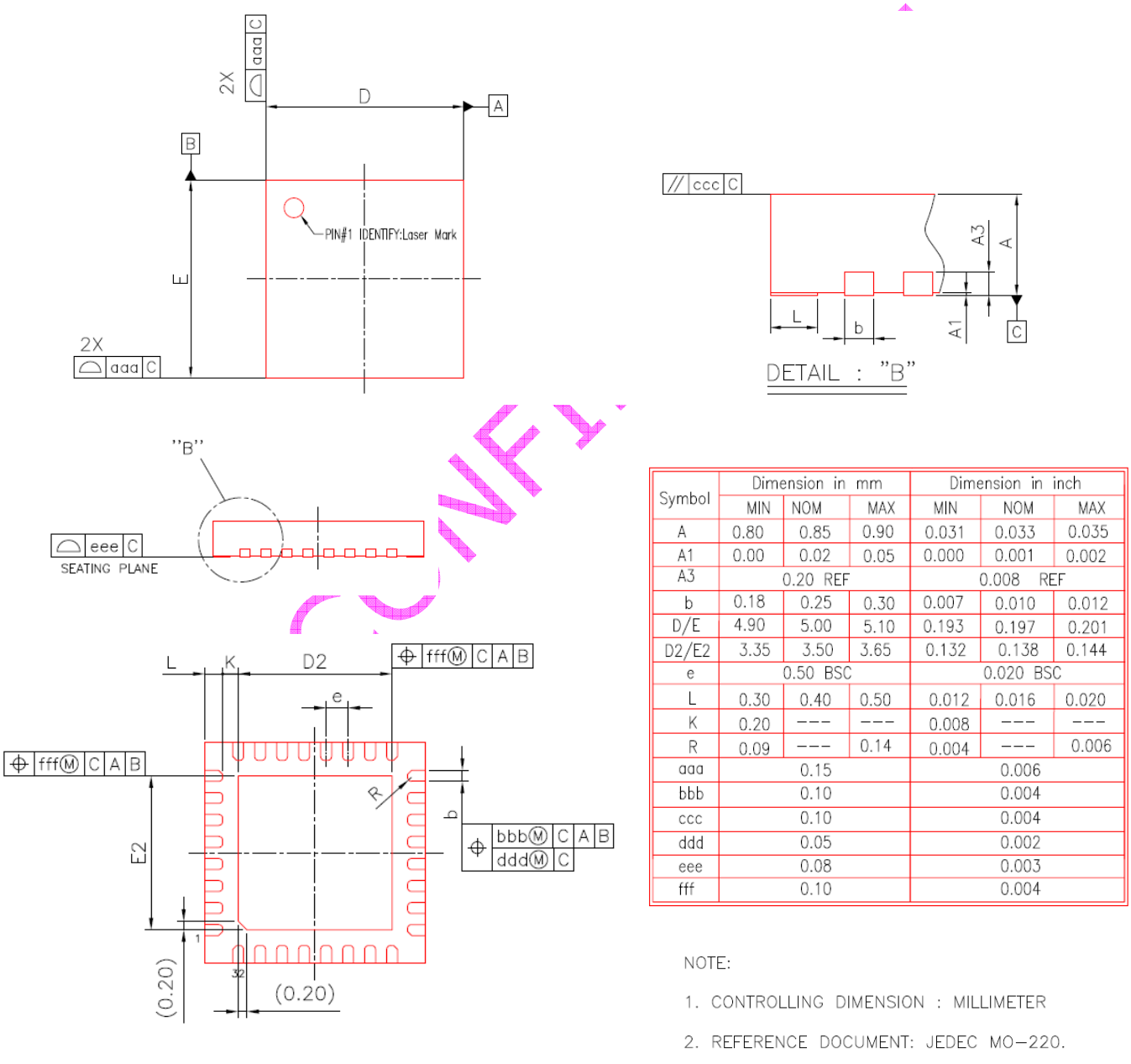
USB High Speed DC/AC Characteristics

Symbol	Parameter	Min	Max	Unit	Note
V_{HSSQ}	High-speed squelch detection threshold	100	150	mV	—
V_{HSCM}	High-speed data signaling common mode voltage	-50	500	mV	—
V_{HSOI}	High-speed idle level	-10	10	mV	—
V_{HSOH}	High-speed data high	360	440	mV	—
V_{HSOL}	High-speed data low	-10	10	mV	—
V_{CHIRPJ}	Chirp J level	700	1100	mV	—
V_{CHIRPK}	Chirp K level	-900	-500	mV	—
Z_{HSDRV}	Drive output resistance	40.5	49.5	Ω	—
T_{HSR}	High-speed Rise Time	500		ps	—
T_{HSF}	High-speed Fall Time	500		ps	—

Package Mechanical Specifications

QFN-32 Pb-free Maximum Temperature for IR Reflow

Parameter	Value	Unit
Maximum Temperature Tp	250	°C
Max Time within 5°C of Tp	30	Seconds



Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3		0.20 REF			0.008 REF	
b	0.18	0.25	0.30	0.007	0.010	0.012
D/E	4.90	5.00	5.10	0.193	0.197	0.201
D2/E2	3.35	3.50	3.65	0.132	0.138	0.144
e		0.50 BSC			0.020 BSC	
L	0.30	0.40	0.50	0.012	0.016	0.020
K	0.20	---	---	0.008	---	---
R	0.09	---	0.14	0.004	---	0.006
aaa		0.15			0.006	
bbb		0.10			0.004	
ccc		0.10			0.004	
ddd		0.05			0.002	
eee		0.08			0.003	
fff		0.10			0.004	

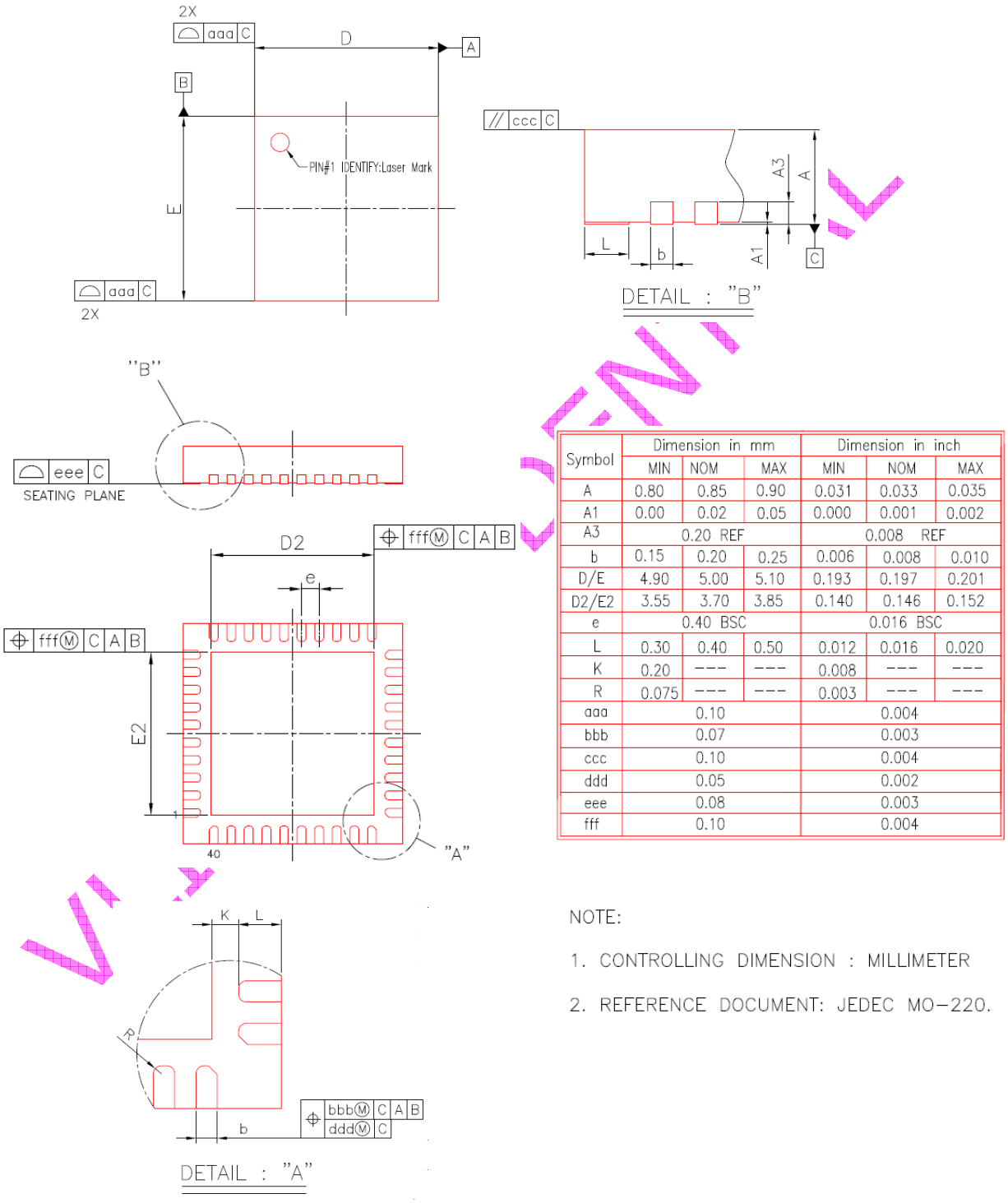
NOTE:

1. CONTROLLING DIMENSION : MILLIMETER
2. REFERENCE DOCUMENT: JEDEC MO-220.

Figure 8 – QFN 32L 5x5x0.85 mm Mechanical Specification

QFN-40 Pb-free Maximum Temperature for IR Reflow

Parameter	Value	Unit
Maximum Temperature Tp	250	°C
Max Time within 5°C of Tp	30	Seconds



Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3		0.20 REF			0.008 REF	
b	0.15	0.20	0.25	0.006	0.008	0.010
D/E	4.90	5.00	5.10	0.193	0.197	0.201
D2/E2	3.55	3.70	3.85	0.140	0.146	0.152
e		0.40 BSC			0.016 BSC	
L	0.30	0.40	0.50	0.012	0.016	0.020
K	0.20	---	---	0.008	---	---
R	0.075	---	---	0.003	---	---
aaa		0.10			0.004	
bbb		0.07			0.003	
ccc		0.10			0.004	
ddd		0.05			0.002	
eee		0.08			0.003	
fff		0.10			0.004	

NOTE:

1. CONTROLLING DIMENSION : MILLIMETER
2. REFERENCE DOCUMENT: JEDEC MO-220.

Figure 9 – QFN 40L 5x5x0.85 mm Mechanical Specification

Package Top Side Marking

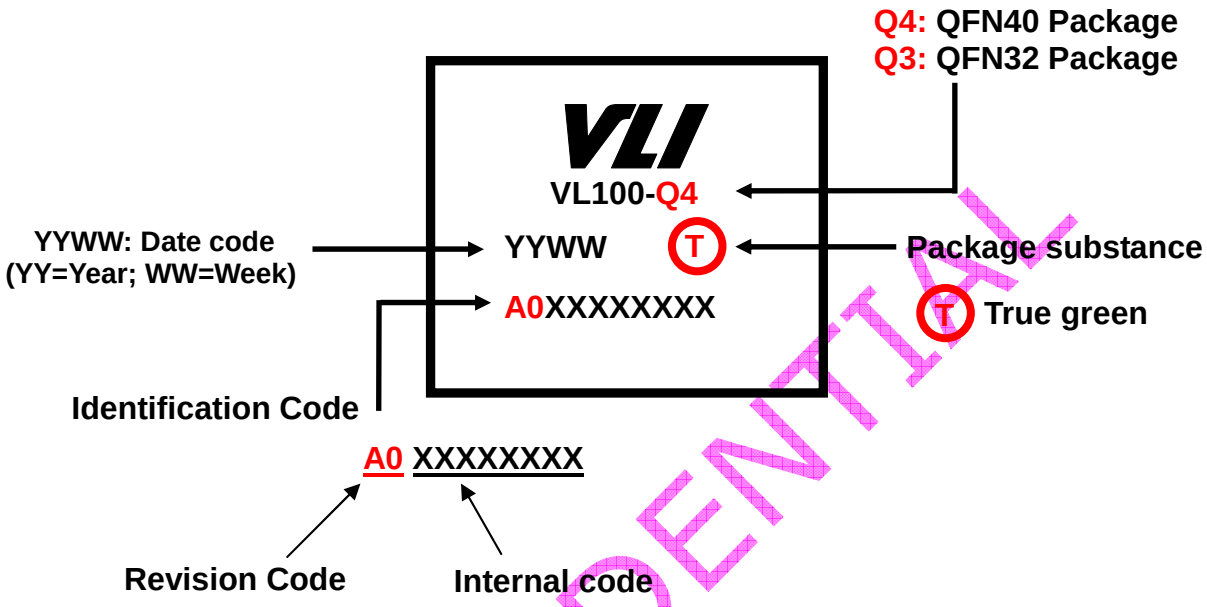


Figure 10 – VL100 Package Top Side Marking

Ordering Information

Part Number	Description	Package
VL100-Q3	DP Alt-mode Controller for USB Type-C Plug (One charging UFP only, Ra Built-in)	32-pin QFN (5x5mm)
VL100-Q4	DP Alt-mode Controller for USB Type-C Plug (One charging UFP, one sink port, Ra Built-in)	40-pin QFN (5x5mm)
VL100R-Q4	DP Alt-mode Controller for USB Type-C Receptacle (One charging UFP, one sink port, Rd Built-in)	40-pin QFN (5x5mm)

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